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MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

Vol. XXXII. *June* 14, 1872. No. 8.

Professor Cayley, President, in the Chair.

The Rev. Thomas Tordiffe, Workington ;
The Rev. Wm. Falconer, Bushey ;
The Rev. F. W. Hall Courtier, Clare College, Cambridge ;
Edw. Sheppard, Esq., Winchester ;
W. M. Williams, Esq., Woodside, Croydon ; and
H. W. Jackson, Esq., Tooting,

were balloted for and duly elected Fellows of the Society.

Spectroscopic Observations of the Zodiacal Light, in April 1872, *at the Royal Observatory, Palermo.* By C. Piazzi-Smyth, Astronomer Royal for Scotland.

Introductory Account.

Having been required last winter to seek a warmer climate for a time, I endeavoured when away to utilize the opportunity by repeating those observations on the zodiacal light, in which I had completely failed in obtaining any positive result through the whole spring season of 1871, on the top of Calton Hill, Edinburgh. The failure there arose from the smokiness and gas-illumined atmosphere of a northern city, preventing so faint and low a light influence as the zodiacal manifestation is there, being ever seen or recognised as such.

But when fine weather broke at last upon me, on March 1, 1872, in latitude 40° 30′ N., far away from gas and smoke, I did expect to see something that evening, though I was hardly prepared for the full magnificence and vigour with which, from 8 to 9 P.M., local mean time, the well-known lenticular form of the zodiacal light was seen cutting obliquely up amongst the

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stars, and contrasting notably with everything else visible in the sky at the same time. Thereby the remembrances of thirty years ago, in S. Lat. 33°, were instantly brought back to me; the zodiacal light was still to my eye as it was then, several times brighter than the Milky Way, of regular mathematical figure and shading, and altogether one of the grand phenomena which an astronomer might worthily desire to probe the possible nature of. So also it continued to be seen, changing its place regularly among the stars with the Sun's motion, both in Right Ascension and Declination, through the months of March, April, and May, whenever absence of the Moon, twilight, and clouds, permitted a fair observation to be taken in any latitudes approaching to 38° or 40° north.

During the middle of the month of March, being stationary in Palermo for a time, I prepared my spectroscope, at the hotel window where I was staying, for acting on the zodiacal light as soon as the moonlight evenings should cease. But having in the meanwhile made the personal acquaintance of Signor Cacciatore, the Director, and Professor Tacchini, the chief observer in the Royal Observatory of Palermo as well as secretary to the Spectroscopic Society of Italy and editor of its transactions, they saw the apparatus on paying me a visit one day, and immediately proposed that I should institute all the intended observations at their Royal Observatory, whose elevated situation was far more appropriate for the purpose than any house in the city below. To this proposal, made in the most admirable spirit of fraternal accord in working for the promotion of knowledge, I was most happy to consent, and all the more because opposite conclusions in the problem were already in the field, and I wished no step in my process to be concealed or mysterious. So during the several days which must still intervene before the Moon should be completely eliminated from the early night sky, the apparatus was taken to the Palermitan Observatory, and tried occasionally on test-objects; while in frequent day visits I profited in solar spectroscopy by seeing Signor Tacchini's masterly handling of the 20-prismed instrument attached to the Palermitan equatoreal, comparing his daily drawings of red prominences with those furnished for the same dates by Padre Secchi at Rome, and Signor Lorenzoni at Padua; and generally in reading up all that Italian spectroscope astronomers had been doing for some time past, both on the aurora and zodiacal light, as well as on the Sun, in the papers, both printed and MS., of "the Spectroscopic Society of Italy," freely lent to me.

At last the first favourable evening arrived, the spectroscope was already in suitable position for its cosmic work at the Observatory; and on April 1, from 7.45 to 8.50 P.M. the zodiacal light, admirably and characteristically visible, was well worked by Signor Cacciatore and myself; again, on 3rd of April, during the same hours, by Signor Cacciatore, Signor Tacchini, and myself; and again, on the 5th of April, by Signor Cacciatore,

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Signor Ricca, my wife, and myself. Each evening gave the same results, and every observer saw the same spectrum in the same manner, excepting only in some minute and unimportant residual differences of different eyes when tried on an instrumental appearance of the very last degree of faintness. And the spectrum which was thus found for the zodiacal light was a short continuous spectrum extending from near to W.L. 5550 to near W. L. 5000, and culminating as to its brightness in or about W. L. 5350, while it was shaded off indefinitely into darkness at either end.

In short, a spectrum this was, as different from that of the aurora when seen in the same instrument, "as night from day," according to the description of a lady who had seen the spectra of both these phenomena in the same instrument, on different occasions, and was invited to give her opinion in the Palermitan Observatory on our concluding zodiacal light evening of April 5 —an opinion, too, in which I perfectly coincide; but then I am required as a man to give a reason for the opinion that was in me, and to show that no other was possible to any good head or clear eye. I must crave, therefore, sufficient space to set forth,—

1st. A description of the Edinburgh faint-light spectroscope.

2nd. Comparison of the new results, with older ones already published; and

3rd. Phosphorescence spectra, astronomical and terrestrial.

The Edinburgh Faint-light Spectroscope.

This instrument was built up by degrees at home in 1870 and 1871. I could make a better one now, and applied to the Royal Society before going out in February for a portion of the Government grant to construct such an apparatus specially for the zodiacal light; but as the Council refused to give me anything, I had no resource but to continue the employment of the old instrument, intended mostly for the aurora, but capable, fortunately, of proving some points in observation which are generally rather uncertain at night, and particularly with portable instruments in unusual situations. Thus, say that an observer looks (as I did when at sea on March 1, 1872) at the zodiacal light with a little hand spectroscope casually purchased, and sees something or other excessively faint near the middle of a perfectly dark field, what account can he give of it? The light is too weak to show any colour; there is nothing else visible in the darkness to fix the spectral place by, nor to prove the width of the slit, nor the focal sharpness of that slit, nor to show the amount of dispersion of the prism; yet each and all of these points should be fixed there and then, or nothing certain has been arrived at.

The above observation-difficulty was met in the larger

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Edinburgh apparatus by employing invariably a reference spectrum formed out of the blue part of the flame of an alcohol lamp, very slightly tinged with sodium and lithium chlorides, but with all the upper yellow or continuous-spectrum giving part of the flame cut off. This sort of light, then, being brought in sideways, and passed by reflection through the lower part of the same slit and prisms used in examining the cosmic phenomenon, gave its own known spectrum in the lower part of the field, and enabled the observer, though in perfect darkness, to know, first of all, whether he was looking straight into the prism eyepiece; second, to test the focus of slit by the sharpness of the edges of the lithium and sodium lines; third, the breadth of the whole field by the visibility of all the five bands of the blue alcohol light from red to violet; fourth, the width of slit by the width of the above lines compared with their distance asunder; and fifth, the dispersion power of the prisms by the degree to which, with the finest slit and the best focus at that part of the spectrum, either the citron or the green band of the blue flame could be separated into its component fine lines; such state of the slit and focus being found also to be the best for seeing the Fraunhofer black lines by day in the same spectral region.

Now in the Edinburgh apparatus, when consisting optically of a slit, an achromatic collimating lens adjustible for focus, and a direct-vision prism-combination about four inches long, I could with such a "Fraunhofer-line slit," directed on the reference-lamp, only fancy that I saw the separate lines: *i. e.* the resolution of the *bands* was not clear, though it had commenced.

With a second similar prism, or with a little opera-glass used in addition, the resolution of the bands was certain, and their lines were seen separated from each other by about twice their own thickness; but these additional aids to dispersion effects could never be used with advantage on the zodiacal light by reason of the peculiar faintness of its spectrum.

Two similar alcohol lamps being simultaneously employed on a certain preliminary occasion, one was looked at direct with the telescope tube as a cosmic phenomenon, while the other was placed in the standard manner on one side of the tube as a reference lamp inside a dark lantern. The spectra of the two lamps were then seen in the prism eyepiece spread horizontally, one over the other, and every band and every line of the one was standing in exact vertical coincidence over those in the other, saving a very little ragged light along the base line of separation of the two spectra, but which was of no real moment. There could then be no reason, on substituting the zodiacal light for the one lamp at the end of the tube, why the zodiacal light's spectrum, if bright enough, should not be seen honestly and fairly standing over the lower spectrum derived from the side reference lamp.

Our place of observation was unexceptionable. A window looking west out of the upper part of the Royal Observatory of

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Palermo, and that observatory again standing on the summit of the Royal Palace, at 120 feet above the ground; that, too, a rising ground, looking far over the house-tops of the city, at a horizon formed of distant dark hills. A few lamps from a square far below did shine up at us, but a black cloth spread over the balcony cut off their rays; and every light was excluded from the apartment we were in, excepting only the reference-lamp of the spectroscope, and that was allowed merely to throw a small portion of its faint blue base of flame into a concealed part of the instrument. The slit of the spectroscope, too, was perfectly protected from stray side-light, for it was at the bottom, or inner end, of the blackened telescope tube of the apparatus—a tube originally intended to carry a large collecting object lens, but the use of which lens was found rather prejudicial than otherwise as to brightness on so broad a surface as that of the zodiacal light.

From that window, then, of the darkened room at the top of the palace, we looked out to the west, and there was the zodiacal light brilliant, so to speak, instantly recognised by all of us as being, as it should be, for the vernal equinox in Lat. 38° N., and vastly brighter than it ever could be seen in any very northern city as of 50° or 60° Lat. Upon that most visible zodiacal light, then, we directed the grand tube of the spectroscope, its slit being arranged narrow, or as most suitable to resolving the reference of blue flame bands into lines; or, as I may add from long Edinburgh experience, for seeing and identifying the one bright line formed by the peculiarly monochromatic light of ordinary green aurora. On looking into the eye-piece, there were all these bands of the reference spectrum with symptoms of linear resolution, together with the lithium and sodium lines thin, as representing the fine slit, ranged across the lower part of the field; but in the upper part of the field where the spectrum of the zodiacal light ought to have appeared, there was nothing. To make quite sure, the instrument, carrying the reference-lamp along with it, was moved slowly, first in azimuth and then in altitude, backwards and forwards across all the brightest parts of the zodiacal light; the reference-lamp, too, was dulled, and at last altogether excluded, but still nothing whatever was seen on looking with the prisms through the slit at the zodiacal light, which otherwise was not only abundantly bright to the naked eye, but also when viewed through the same prisms if used without any slit at all.

The only explanation, then, that is possible for the non-appearance of any spectral light, whether in lines, bands, or anything else, when the fine slit was used, is, that the light of the zodiacal manifestation is not, as has been sometimes asserted, monochromatic light of one definite refrangibility (in which case it could only give a line as bright as the full phenomenon, and as narrow as the slit), but it is of many various refrangibilities, and

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spread thereby over so large a spectral range as to become weakened down to practical invisibility.

To ascertain over how great a spectral range the zodiacal light is spread, the slit was opened slowly until *something* was seen in the dark field, and then it was no line or lines, but a short portion of continuous spectrum that was indicated, becoming clearer, and rather larger too, when the slit was still further widened. Indeed we made the slit at last even extravagantly wide, or approximating in such breadth to the length of the said portion of continuous spectrum itself.

This portion, however, was never definite, never bounded by sharp upright parallel lines, as were the lines of lithium and sodium with that broad slit; but it was shaded off gradually into darkness at each end, and had its general maximum of light rather nearer the less refrangible end. Moreover, it was altogether so faint, as well as undefined and indefinable at the same time, that it could never be seen certainly in conjunction with the reference spectrum, the latter having to be excluded and then let in again, so that the comparison of the two might be made by memory assisting the eye.

These characteristic features of the zodiacal-light spectrum are represented in an accompanying plate in its spectrum pairs 1, 2, and 3, and are, I believe, substantially agreed to by Signor Cacciatore and Professor Tacchini, as well as myself.

Comparison of the new results with older ones already published.

To prevent any needless delay, as happened to a similar case last year, in examining, weighing, and publishing these results of observation, I refrain from mentioning the *names* of the various leading spectroscopists of the day, by whom totally opposite conclusions from those now detailed have been arrived at; it is sufficient for the scientific discussion of the case as it exists in nature, to mention what these distinguished astronomers have concluded, and to remind that their decisions have hitherto been generally accepted by the public, and are considered to have proved, that the spectrum of the zodiacal light *is the same as that of the aurora.*

And what *is* the spectrum of the aurora like, according to these authorities?

The chief part of them say that it is for the ordinary pale aurora simply monochromatic, or consisting, with a fine slit, of a single and sharp definite greenish line near W. L. 5579; yet some amongst those authorities there are who stand out for a rather brilliant continuous spectrum also. These latter persons, however, I do not scruple to say, are in error. They were generally those upon whom, in Southern European latitudes, the splendid aurora of February 4 came so astoundingly and unprecedentedly

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that they rushed out—all inexperienced—with chemical spectroscopes, telescopic-star spectroscopes, sun-prominence spectroscopes, and anything at hand, however inappropriate, and hazarded a spectroscopic shot at the unusual phenomenon, under circumstances exciting, fascinating, agitating, to the last degree ; and never repeated since. I saw too, some time afterwards, also in a Southern university, how a grand continuous spectrum might have been incontinently obtained by the use of one of those instruments, even out of, or with the monochromatic green light of aurora, and from the red portion too on that unique occasion.

The party in question had a magnificent 4-prism chemical spectroscope, and desired very obligingly to show me the D lines in daylight from the blue sky, as seen through a window of the apparatus-room. The party laboured and laboured, but could get no lines at all, only an impure continuous spectrum. At last a friend of rare skill arrived, who discovered that the portion of light entering direct through the slit was swamped by the superabundance of the light entering slantingly *behind the slit* into the hole of vision in the side of the brass box covering the prisms. This was an effect which would not have occurred if the source of light had been small, but was thus destructively powerful when the source was of large area, as it was undoubtedly either with the said window, or still more with the aurora of Feb. 4, for that was on all sides of the heavens at the same moment.

What then, with auroral light pouring unexpectedly into the spectroscope by a circular hole 1·3 inches in diameter, the indiscreet use of lamps, and the insufficient avoidance of other lights on an *impromptu* occasion of promiscuous observing, there is no difficulty in explaining the false continuous spectra once ascribed by certain persons to the aurora, even when using a fine slit. Hence we may fall back in confidence on the accounts of the larger part of spectroscopists who say, and say truly, with the first of all auroral observers, M. Angstrom, that with a *fine slit* on an *ordinary aurora*, they see only one fine or thin greenish line.[*] So fine, sharp, and bright, indeed, is this line, or so undiluted by dispersion, that even on faint beams of aurora, not brighter than the zodiacal light, and with a fine slit, of course, I have myself used three times the dispersive power that that latter phenomenon would not bear even with a broad slit; and still, not only have I then seen the auroral line distinctly, but compared its place neatly against that of the second line in the citron band of the blue base of alcohol flame in W. L. 5579.[†]

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[*] I am confining myself here to an ordinary, or greenish aurora, and a fine slit: what may be seen on a red and extraordinary aurora, and with a wide slit, I have already described in the *Edinburgh Astronomical Observations*, Vol. XIII.

[†] See Spectrum-pair 7 in the accompanying plate; also the plates in the XIIIth Volume of *Edinburgh Astronomical Observations*. I have since then learnt, by correspondence with Dr. W. M. Watts, and by reading his useful little book, *Index of Spectra*, that each of the fine lines which I describe in the

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If, then, the true state of the case stands thus, that the ordinary auroral fine-slit spectrum is one thin fixed line, how can those persons be justified who assert that it is the same spectrum as that of the zodiacal light, viz., that very one which we have shown, I hope, incontestably, to be a most diluted and dispersed portion of continuous spectrum, broad, indefinitely shaded off at either end, and far too faint to be appreciated by the human eye when employing a narrow slit and prisms of a decent amount of dispersive power? My answer must stand thus:—

1. Some of the observers were in high latitudes, and had not eliminated their frequent auroral glows from their only occasionally supposed and most faint zodiacal light. They ought evidently to try their observations over again in parts of the world where there is less aurora and more zodiacal light.

2. None of the observers, whose accounts I have been able to read, employed any reference spectrum to prove either the focus, breadth of slit, dispersion, place in spectrum, or any other necessary condition under which they were observing: and there are documents against some of them, connected with their alleged places of the principal aurora line on Feb. 4, showing that they cannot safely dispense with such instrumental check and guide, even in a far easier case of observation than that of the zodiacal light.

3. The spectroscopes employed were generally little portable things of such small dispersion but very tall slits, as to make what was really a broad tract of continuous spectrum to look like a narrow band, or an ill-defined line; and this appearance being seen in an instrument whose focus may be rather uncertain at night, and which has on previous occasions shown the auroral line instrumentally blurred, is hastily declared to be a line also.

4. Other observers, again, who, with a broad slit, have seen the continuous spectrum of the zodiacal light, and have marked a fine bright line, like that of the aurora when seen with a fine slit though in a different spectrum place, down the middle of it, have let their fancies run away with their judgment and have pictured that which is spectroscopically impossible, considering the large surface of the zodiacal light, no matter what the physical characteristics of that light may be, monochromatic, polychromatic, or anything else.

5. And, finally, those observers who have painted a very *brilliant* picture of the zodiacal light spectrum, whether continuous or linear, have failed in representing one most characteristic feature of the fact, viz. its faintness.

In short, though I am sorry to say it, none of the observers who have declared for the spectra of the zodiacal light and aurora

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coloured bands of blue flame base, or acetylene, or carbon, breaks up, under higher dispersion, into a finer species of lines still; but *their* places do not seem to have been determined yet by any one; and his final wave-length numbers still therefore apply to my "lines," though to his bands; my "bands" being his groups.

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being the same, have proved any of the necessary elements of their observing methods.

Phosphorescence Spectra, Astronomical.

Not only, however, have we to deal in the present day with the above too often published misleading equation between two grand physical apparitions, but there is another equation of the same order put forth by some of the same high authorities; viz., that on certain nights when "there is a general phosphorescence over the whole sky, the auroral line (W. L. 5579) may be detected in that light equally over it all."

Of course, if the aurora *itself* is spread on any occasion over the whole sky, its line must be spectroscopically recognisable everywhere; but phosphorescence is not aurora, and aurora is not phosphorescence; and that which some observers mysteriously call by this name "phosphorescence," and have never attached any peculiar spectrum to, is, in my humble apprehension, nothing but star-shine and night-light, similarly with sunshine and daylight. Starshine, of course, exists for every one who can see the principal stars; and the night-light of the background of the starry sky is just as certainly a fact, being made up, not only of the reflected light of those brighter stars on our own atmosphere, but of the direct light of myriads of smaller stars far too minute to be individually appreciated by the human eye.

And what sort of spectrum ought such star-shine and night-light to offer to the observer? Not a sharp, aurora-like line at all, but something, according to the manner and locality of its formation, very much like the spectrum of the last twilight of day. In fact, according to numerous observations on the Sicilian night sky, when free from any accusation of aurora, I found such night-shine to yield a short continuous spectrum; and that culminating, not at the aurora line place of W. L. 5579, but near W. L. 5350.

Now this place evidently corresponds within the limits of error of observation to that of the last residual portion of the continuous spectrum of stronger daylight or sunshine (with the eclipse corona line also, at W. L. 5322), modified slightly by the absorbing and reflecting powers of the atmosphere.* No Fraun-

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* On the 6th of April, in Palermo, I made the following observations with the auroral spectroscope, but turned now upon the ordinary evening twilight, the slit being fine or proper for seeing Fraunhofer lines at midday. The alcohol reference-lamp was also employed to give further proof of the state of the slit and to indicate the spectral position of anything that might be seen in the twilight spectrum; which spectrum, in less than an hour, passed through all the following stages.

Stage 1. A continuous bright-coloured spectrum, showing the usual solar and telluric black Fraunhofer lines distinctly.

Stage 2. Continuous spectrum faintly coloured; Fraunhofer lines have now disappeared; but are replaced by darkish bands, probably formed of aggregation

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hofer lines are seen in such star-shine spectrum for these reasons: 1st, the continuous spectrum is too faint to show any black lines upon it clearly; and 2nd, the slit used at the time of observation was too broad to have shown Fraunhofer lines even in noonday shine. Indeed to see the spectrum of general night starshine, the slit of the spectroscope had to be opened wider still than in the case of the zodiacal light; but gave then a closely similar spectrum; and thence we are led to the conclusion that the spectrum of the zodiacal light is the same in kind as that of either star-shine or faint sunshine. Whence the further deduction is inevitable, that the older astronomical theory of the zodiacal light being the solar illumination of infinitely small distant particles such as meteors revolving about the Sun, whether in orbits of infra or ultra planetary ellipticity, is spectroscopically maintained; while, that such solar zodiacal light has any physical connexion with the essentially terrestrial accompaniment of aurora, is just as eminently negatived by the spectroscope: for "no two spectra," as the lady most truly said in the Royal Observatory at Palermo, "can be more essentially different than those of the aurora and the zodiacal light. They are as different from one another as night from day."

Phosphorescence Spectra, Terrestrial.

Yet though our spectroscopic results so decidedly spoke for a solar origin and cosmic nature to the zodiacal light, one of the Italian mainland astronomers has published views very recently, dragging down the said phenomenon not only to the terrestrial region of the aurora, but to the still lower topographical level of meteorology and the bad weather experienced at his own Observatory in the beginning of March.

The weather with him had certainly been very bad during those days; but I had undergone some portion of it myself, having been passing along the Mediterranean from Gibraltar to Palermo at the time; and though, whenever the evening sky was free from clouds, the zodiacal light was conspicuously bright, I

of said lines, combined with the increased haziness of dark lines on a darkish back-ground (a natural law well known to, and made much use of by, successful painters of night scenes): the preponderance of light belonging to the continuous spectrum, is very manifestly in the green region.

Stage 3. The green portion of the continuous spectrum is alone visible.

Stage 4. Green portion is shorter; shaded off indefinitely at either end, and culminating in what brightness it has near or about W. L. 5300.

Stage 5. Too faint now to be seen simultaneously with reference-spectrum: is seen again on widening the slit.

Stage 6. Too faint again to be seen simultaneously with reference-spectrum, even with a broad slit; but on excluding reference-spectrum the twilight spectrum may again be seen, and is found to resemble in shape, position, and all visible characters the zodiacal light spectrum as already described. The general starlight spectrum, or the spectrum of the night-shine amongst the stars above the reach of twilight or zodiacal light, is also of the same order, but fainter, and requiring a broader slit to be appreciated at all.

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could not see, and the said theorist has made no attempt to prove, that it was in any way, or degree, brighter than it should have been for that latitude in that season of the year; that season, *i. e.* the beginning of March, being, let it be remembered, the long since astronomically determined date of annual maximum evening brightness of the zodiacal light for all places in the northern hemisphere.

The bad weather was accompanied no doubt over my track by a grand development of *phosphorescent* light; but that phosphorescence was in the sea, not in the sky, which, when clouded, was dark enough; and I should not think of occupying the attention of the Royal Astronomical Society with any account of it, had not that strange quality, "phosphorescence"—by name, at least,—been imported into zodiacal light discussions by so many eminent and great men; and had I not succeeded at last in doing what I believe they did not, viz., comparing such phosphorescent spectrum with that of the zodiacal light, as well directly, as through the medium of the reference-lamp.

Now, the phosphorescence here spoken of was peculiar. It was not composed of the little bright stellar sparkles, nor of the globes and discs of fainter light which are frequently seen in the wake of any vessel in many seas; but it was a broad and long trail of nearly uniform milky light, brightest close under the stern of the ship; so bright indeed there, that one could hardly but fancy that there were powerful lamps pouring forth their light from lower stern windows upon the foam-trail of a paddle-steamer. But there were no such stern windows in the "Kedar," and she was not a paddle, but a screw, steamer, keeping the blades thereof always well submerged and preserving by day a dark trail astern free from froth, foam, or bubbles, even under a noon-day sun; yet as soon as night set in, there was this phosphorescent tail, some 8 to 10 feet broad, and of indefinite length, stretching far away in luminous magnificence behind her.

At that time I had only an insufficient hand-spectroscope at command; but on finishing the zodiacal-light observations at Palermo, the same instrument, reference-lamp and all, was transferred on April 8th, to the SS. "Marathon" (belonging to Messrs. Burns and MacIver, of Liverpool), where I was to spend the next five weeks, and where the captain (John Leitch, Esq.), kindly consented to let the instrument be mounted in permanence on deck, so as to be ready for observation at any moment; a condescension to landsmen's science, in a neat and trimly kept ship, as unusual as it was in this instance both gratifying and effectual.

Night after night, however, followed, and there was for a long time very little luminosity of any kind behind this new ship; the Moon, too, was often over bright; and so it happened, that not until the 6th, 9th, and 11th days of May, in seas on either side of Gibraltar and near Lisbon, was there any opportunity of making the long-desired observation of the spectrum of light from a

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similar broad sheet of milky phosphorescence to that so often seen in the "Kedar," Capt. Pritchard. The observation, however, was most satisfactorily taken on the above-mentioned days, up to the limits of power of the instrument, and gave for result,—a short continuous spectrum in the green, culminating at about W. L. 5050; or totally different from the places of both the aurora and the corona lines, much further on in refrangibility than the zodiacal-light spectrum, and having its greatest intensity towards the further, and not the nearer, end of its own light; as will be seen in the diagrams of spectrum pairs 5 and 6 in the accompanying plate of spectra symbolically represented.

Addition to a paper on Errors in Vlacq's ten-figure Logarithms, published in the last number of the Monthly Notice. By J. W. L. Glaisher, B.A., F.R.A.S., Fellow of Trinity College, Cambridge.

The main object of the present addition to my former communication is to correct an inaccuracy therein, and to add several errata with which I have since become acquainted. The inaccuracy (which is of no importance, as far as the object of the paper is concerned), is contained in the following sentence which occurs on p. 259:—"Lefort's list contains 452 errata, 301 of which are marked with an asterisk, to imply that they were given by Vega;" the words of Lefort's note are, "Toutes les fautes, relative aux nombres qui sont marqués d'un astérisque, se retrouvent dans le *Thesaurus logarithmorum completus* de Vega;" and this means, as is evident on examination of any one of the marked numbers, that the errors in question are reproduced in Vega, not that they are pointed out by him; the words, "to imply that they were given by Vega," should therefore be replaced by, "to imply that they occur also in Vega." It does not follow that the number of errors found by Vega in 452 − 301 = 151, as Vlacq's tables proceed steadily from unity to 100,000, with differences throughout, while Vega gives the logarithms of the first thousand numbers (without differences), and then the logarithms of numbers from 10,000 to 100,000, with differences; so that no errors in Vlacq's differences, &c., below 10,000, are noted; this, however, makes but slight practical difference, as this portion of Vlacq is never used.

In my paper I stated that "I had made no examination of Vega's errata-list," feeling, no doubt, that this was completely done by Lefort; but by the aid of it I have since been enabled to add to my list on p. 258, the three following errata in Vlacq's, which are not given in the *Arithmetica*, or by Lefort:—

Number.	Error.	Correction.
26517	43889	43886
30134 Diff.	1,44116	1,44119
64818	56295	56265